Complex Permittivity and Refractive Index for Metals

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The following figures plot the frequency dependent complex permittivity $\epsilon = \epsilon' + \mathrm{i}\epsilon''$ and refractive index $n = n' + \mathrm{i}n''$ for silver, aluminum, gold, copper, chromium, nickel, tungsten, titanium, beryllium, palladium, and platinum using either the Drude (Equation 3), Lorentz-Drude (Equation 4), or Brendel-Bormann (Equation 5 models in the range 200 nm to 2000 nm. The material parameters and mathematical formalism detailed in [1]. These tables are generated programmatically. Three different models for the complex permittivity are tabulated. The first two are the Drude and Lorentz-Drude (LD) models.

$$\epsilon_D = \epsilon_D \tag{1}$$

$$\epsilon_{LD} = \epsilon_D + \epsilon_L \tag{2}$$

where ϵ_D is contribution from the Drude model, representing free electron effects

$$\epsilon_D = 1 - \frac{\sqrt{f_0}\,\omega_p'^2}{\omega(\omega - \mathrm{i}\Gamma_0')} \tag{3}$$

and ϵ_L is the Lorentz contribution, representing the bound electron effects

$$\epsilon_L = \sum_{j=0}^{k} \frac{f_j \omega_p'^2}{\omega_j'^2 - \omega^2 + \mathrm{i}\omega\Gamma_j'} \tag{4}$$

The third is the Brendel-Bormann model which is based instead on an infinite superposition of oscillators

$$\epsilon_{\mathrm{BB}} = \frac{1}{\sqrt{2\pi}\,\sigma_n} \int_{-\infty}^{\infty} \exp\left(-\frac{(x - \omega_n')}{2\sigma_n^2}\right) \frac{f_j \omega_p^2}{(x^2 - \omega^2) + \mathrm{i}\omega\Gamma_n'}\,\mathrm{d}x \tag{5}$$

0.1 Ag

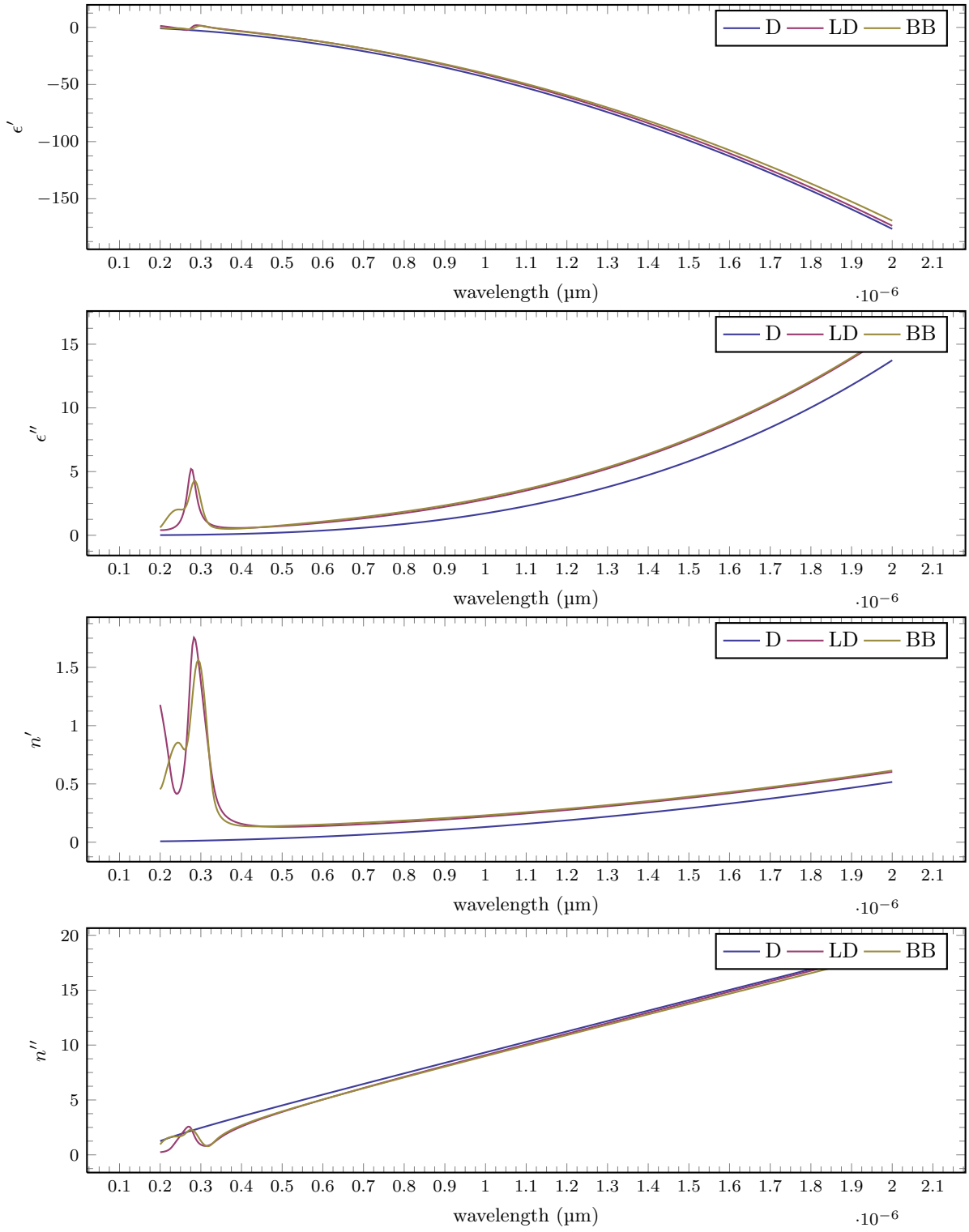

Figure 1: Material parameters for Ag based on the Drude, Lorentz-Drude, and Brendel-Bormann models.

0.2 Al

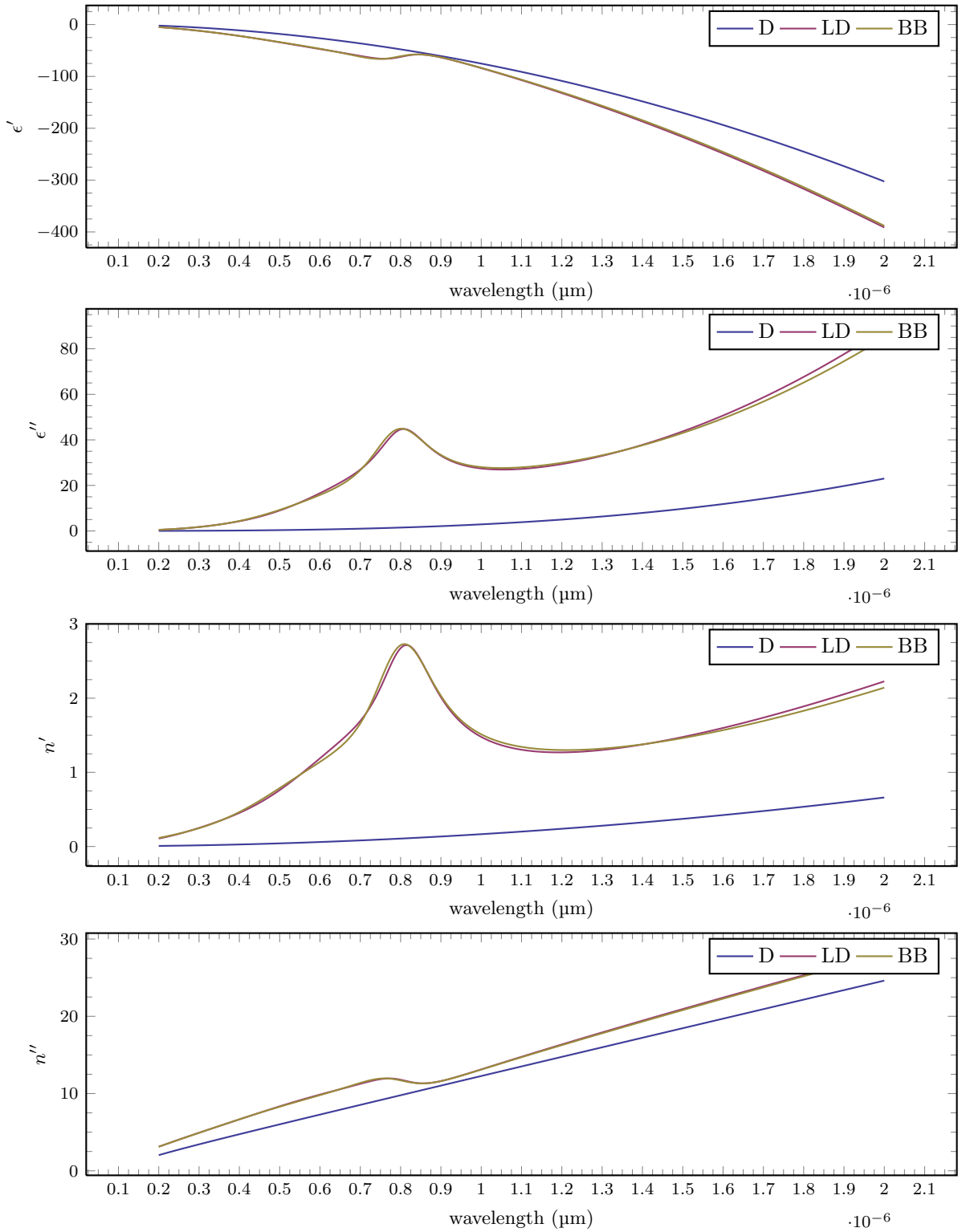

Figure 2: Material parameters for Al based on the Drude, Lorentz-Drude, and Brendel-Bormann models.

0.3 Au

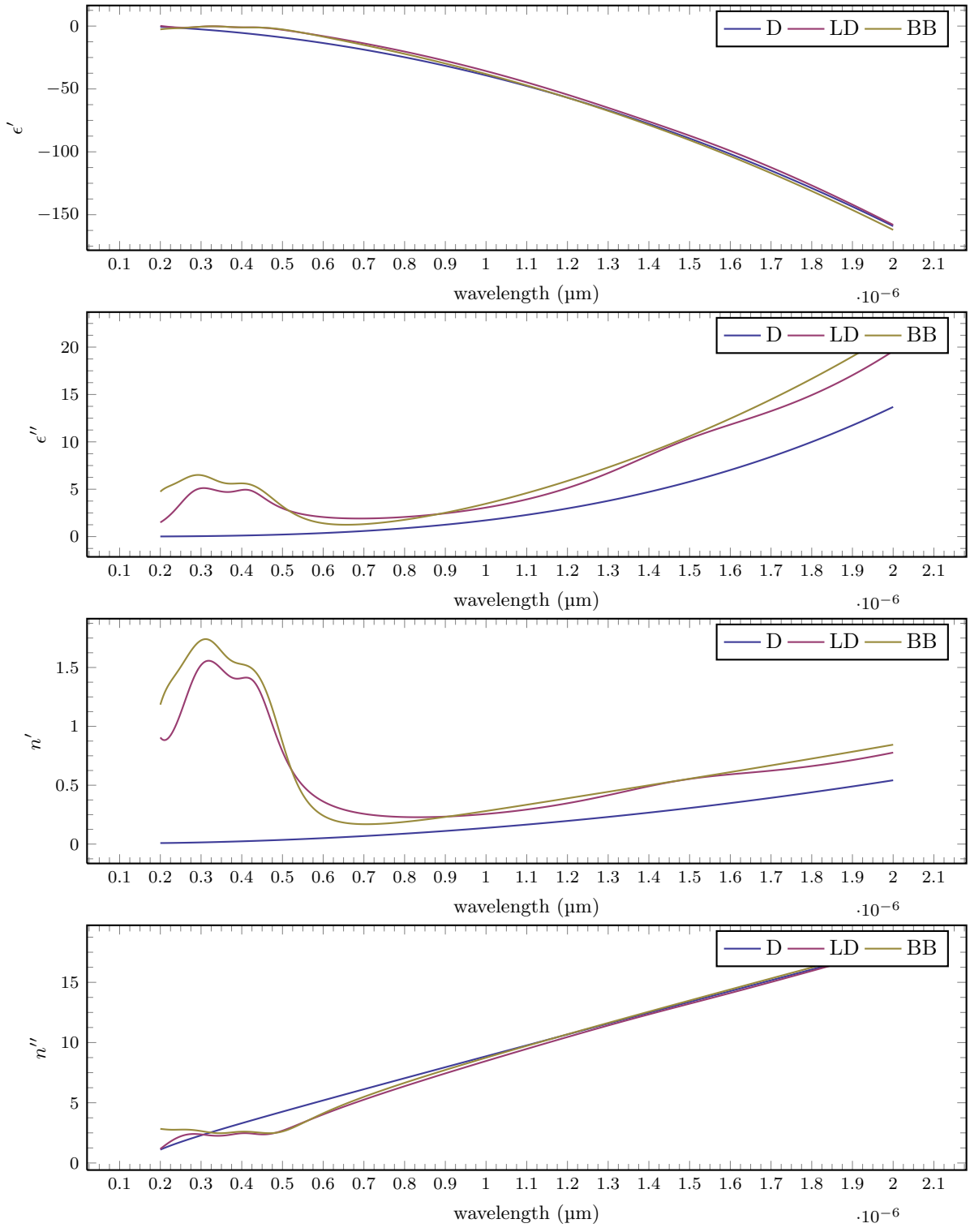

Figure 3: Material parameters for Au based on the Drude, Lorentz-Drude, and Brendel-Bormann models.

0.4 Cu

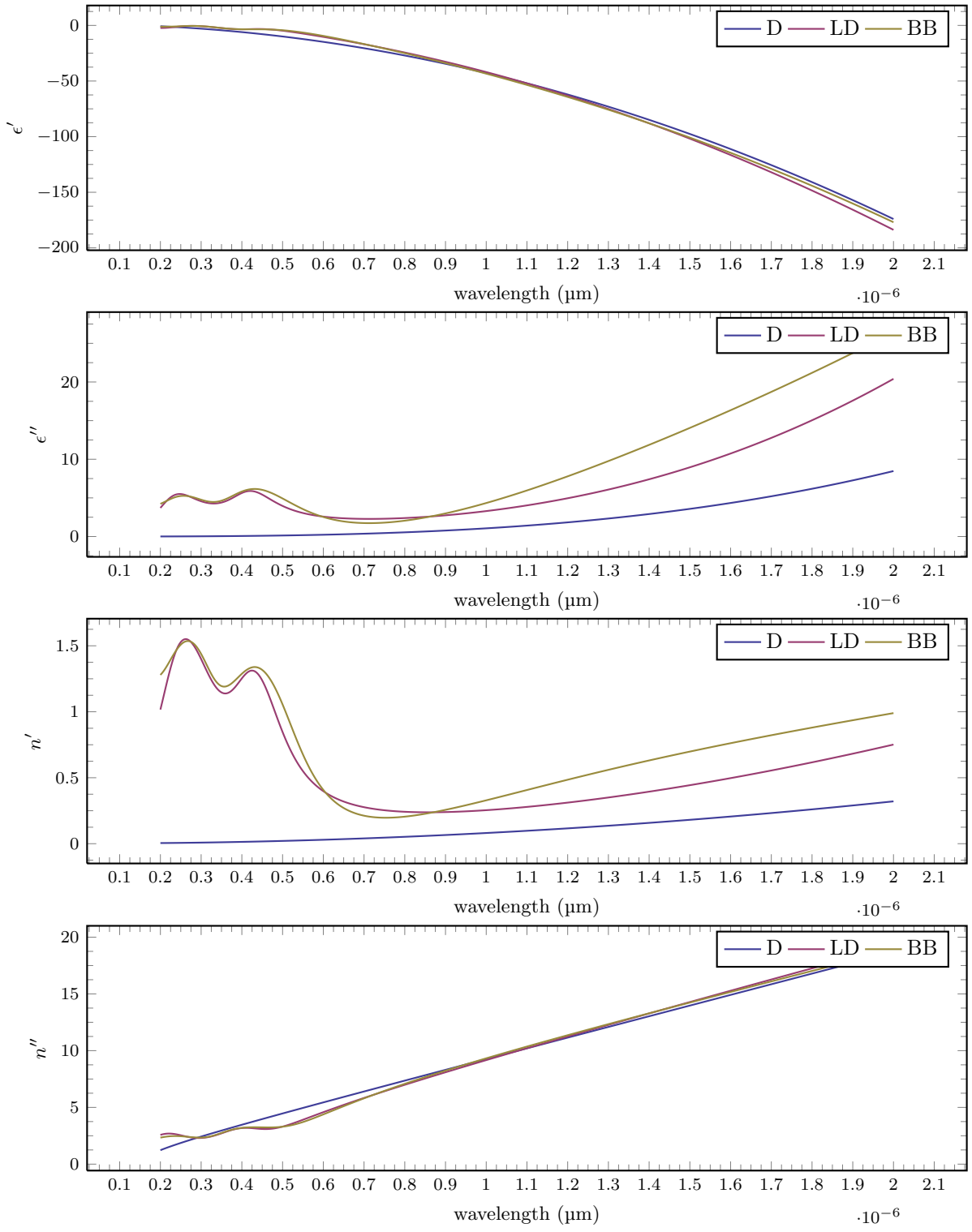

Figure 4: Material parameters for Cu based on the Drude, Lorentz-Drude, and Brendel-Bormann models.

0.5 Cr

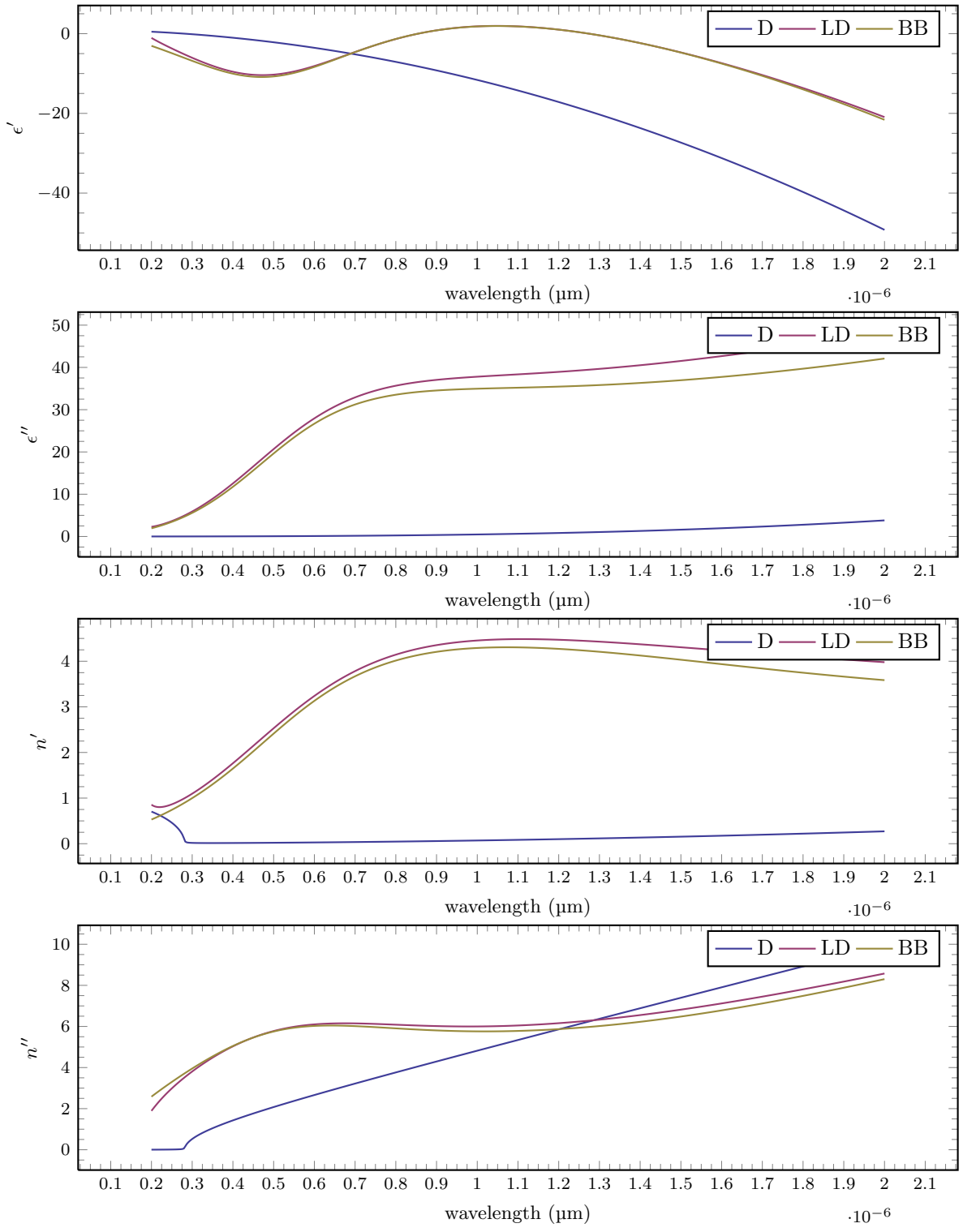

Figure 5: Material parameters for Cr based on the Drude, Lorentz-Drude, and Brendel-Bormann models.

0.6 Ni

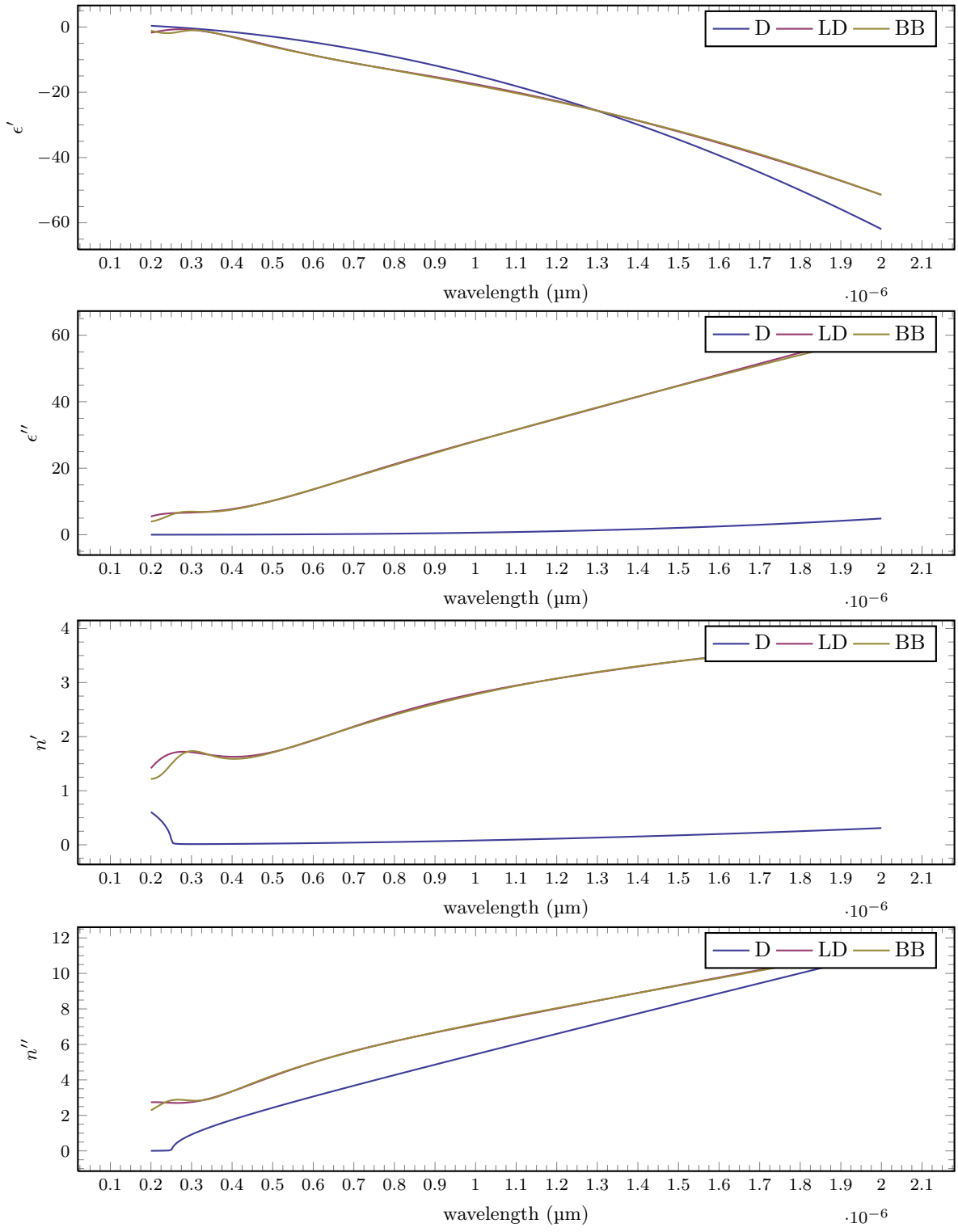

Figure 6: Material parameters for Ni based on the Drude, Lorentz-Drude, and Brendel-Bormann models.

0.7 W

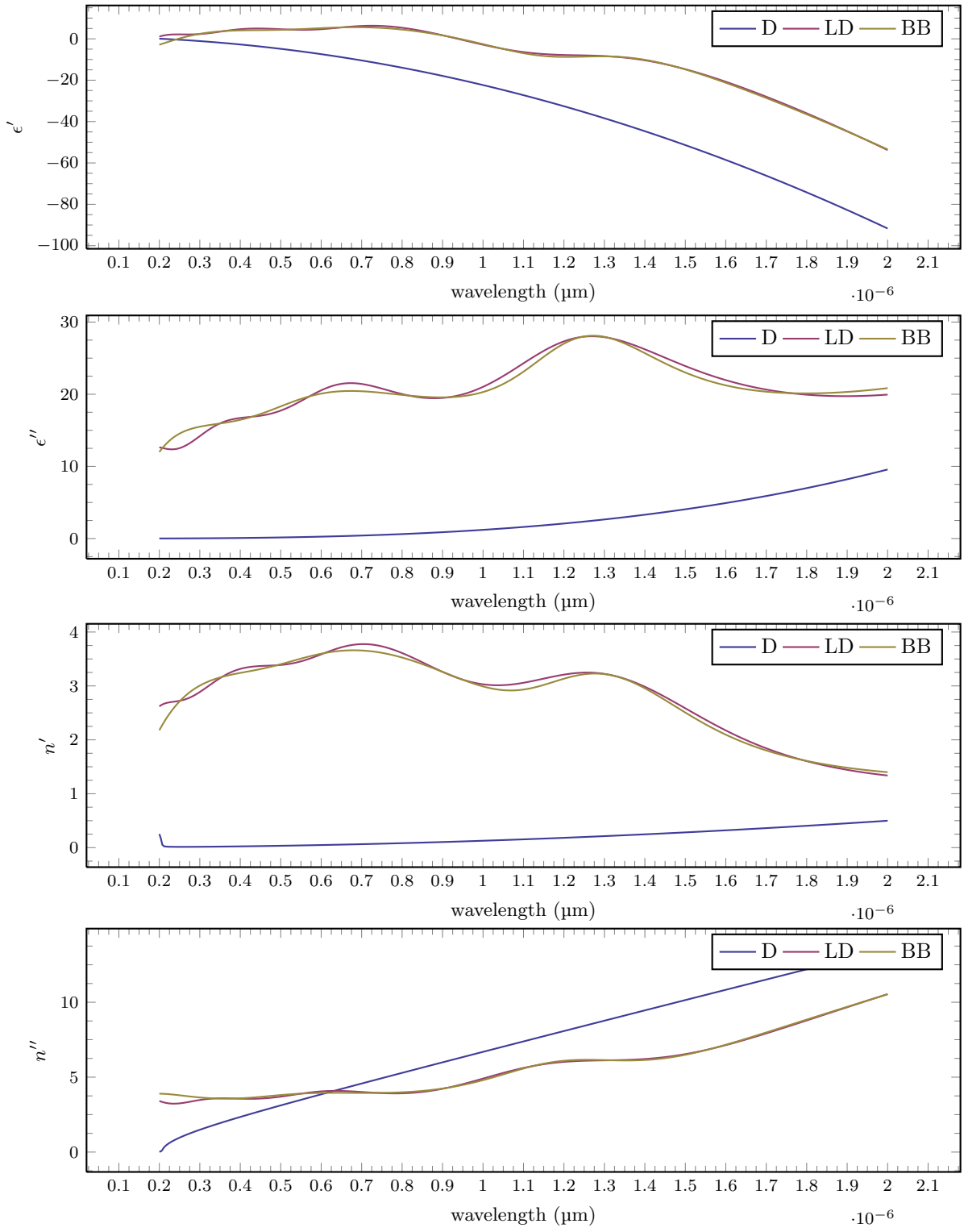

Figure 7: Material parameters for W based on the Drude, Lorentz-Drude, and Brendel-Bormann models.

0.8 Ti

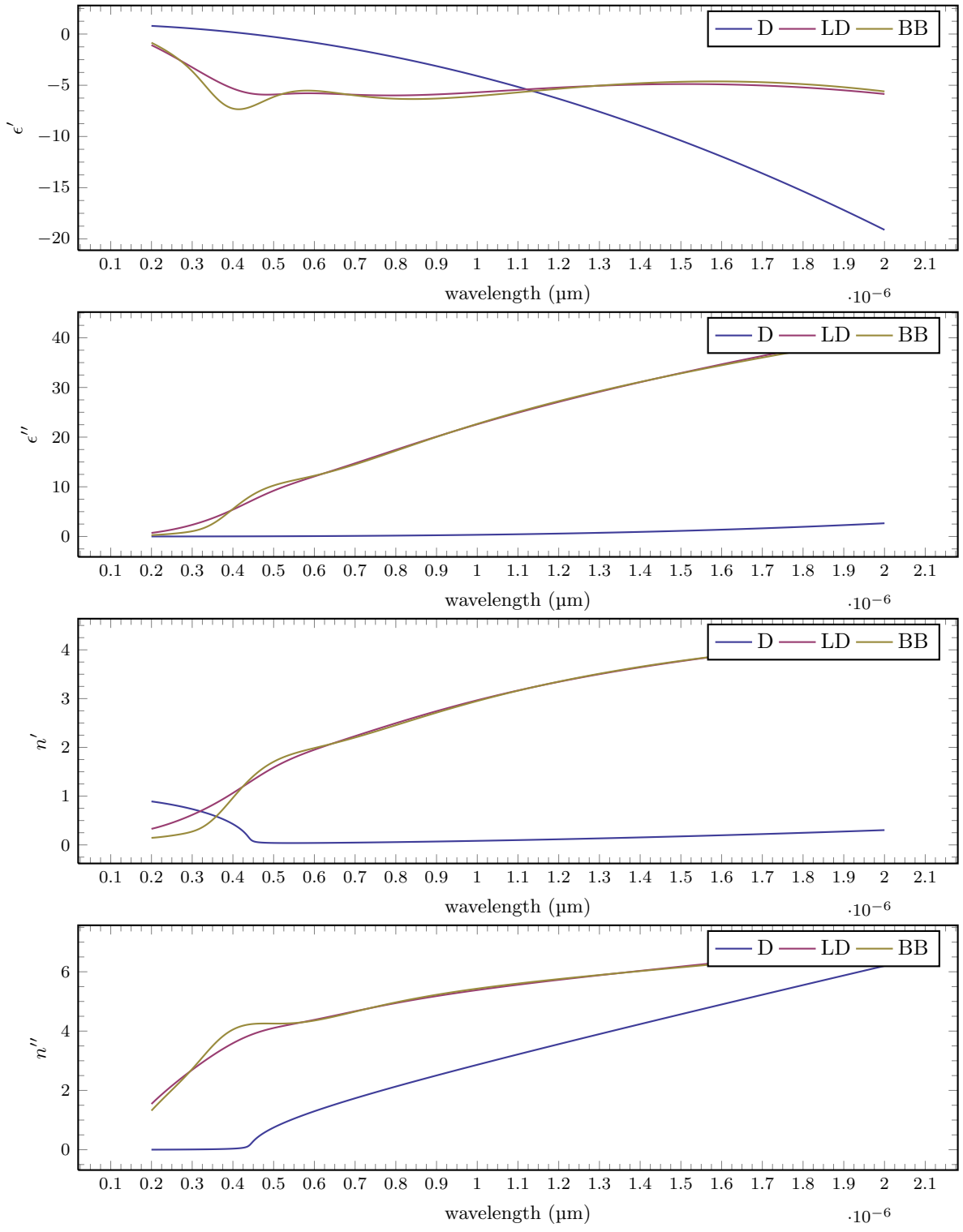

Figure 8: Material parameters for Ti based on the Drude, Lorentz-Drude, and Brendel-Bormann models.

0.9 Be

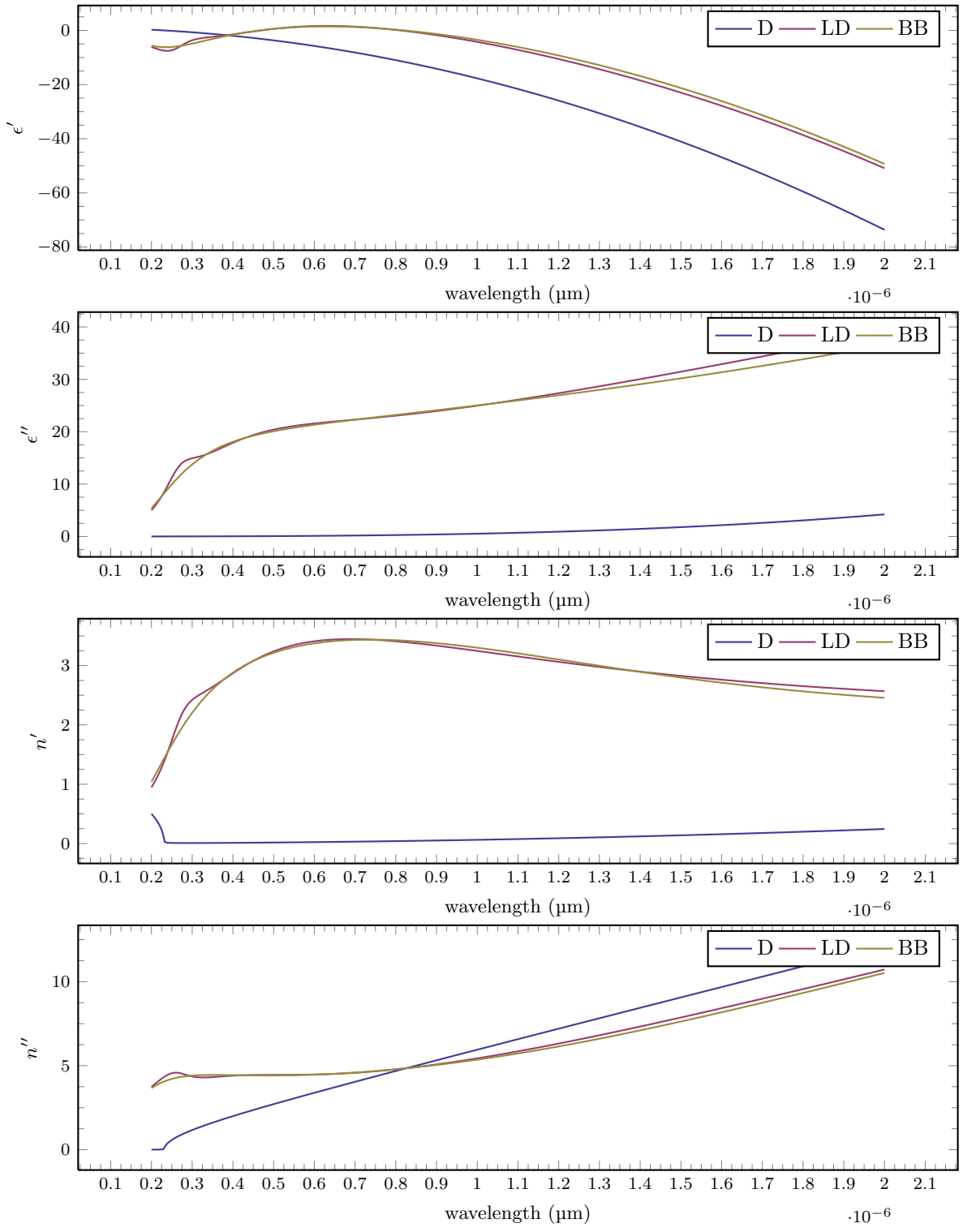

Figure 9: Material parameters for Be based on the Drude, Lorentz-Drude, and Brendel-Bormann models.

0.10 Pd

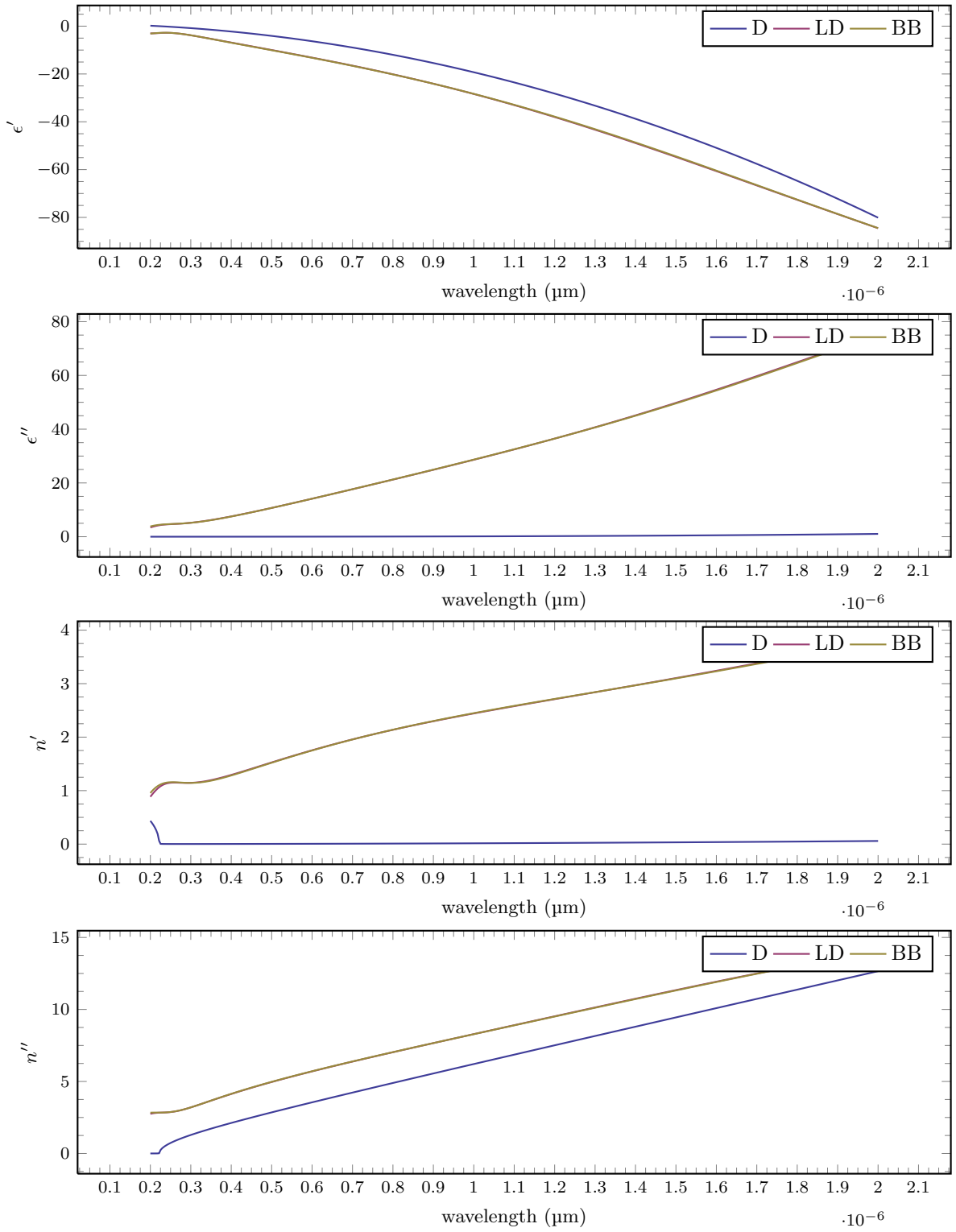

Figure 10: Material parameters for Pd based on the Drude, Lorentz-Drude, and Brendel-Bormann models.

0.11 Pt

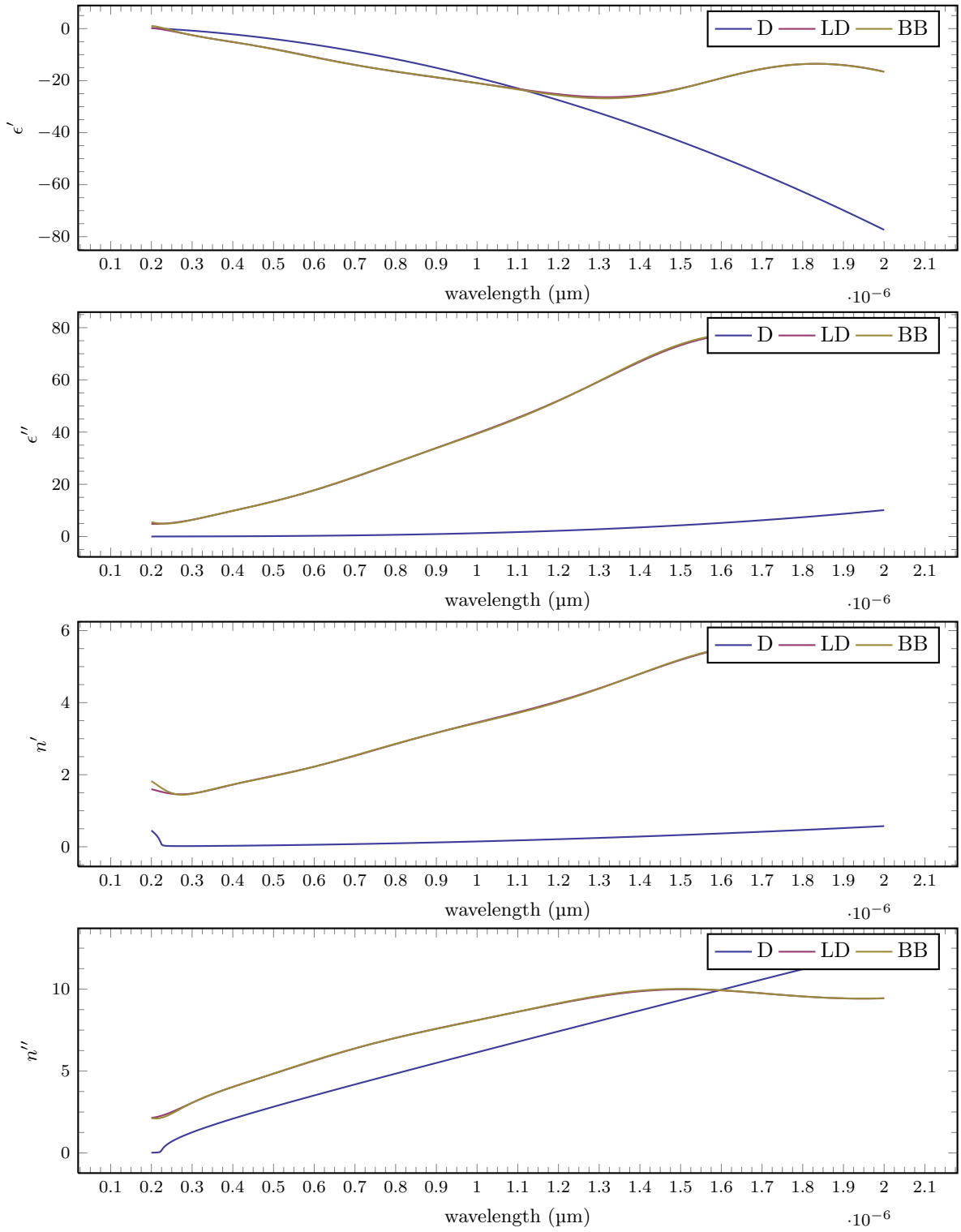

Figure 11: Material parameters for Pt based on the Drude, Lorentz-Drude, and Brendel-Bormann models.

References

[1] A.D. Rakic, A.B. Djurišic, J.M. Elazar, and M.L. Majewski. Optical properties of metallic films for vertical-cavity optoelectronic devices. *Applied Optics*, 37(22):5271–5283, 1998.